to point to the general conclusions that Tanganyika is unlike most of its sister lakes in having been contaminated by incursions of marine organisms at a rather remote period of time. It is certain that there are *two* distinct faunas in Tanganyika, but the ultimate determination of the nature of the more peculiar series which I have just described can only be attained by a thorough comparative study of the morphology of the selected specimens which I have brought home.

In the meantime, however, it may not be unprofitable to point out that there is nothing in the geology of the Tanganyika district which precludes the likelihood of that part of Africa having been occupied by an arm of the sea in ancient times. The massive sandstone formations of this district are probably of Jurassic age; and it is by no means improbable that the rift-valley in which Tanganyika now lies began to be formed shortly after these sandstone beds were raised.

2. On some European Slugs of the Genus *Arion*.

By Walter E. Collinge, F.Z.S., Assistant Lecturer and Demonstrator in Zoology and Comparative Anatomy, Mason College, Birmingham.

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(Plates XXIX.–XXXI.)

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1. *Introduction.*

During the past five or six years I have been enabled, through the kindness of numerous malacologists and other naturalists, to examine exceedingly large series of the various species of European Slugs from numerous localities. Some of the results obtained are detailed in the following notes.

My best thanks are due to Mr. G. H. Carpenter, the able editor of the 'Irish Naturalist,' for the very kind manner in which he has helped me to obtain material from Ireland. My thanks are also due to the following ladies and gentlemen for material they have from time to time sent to me:—Misses M. J. Delap and Amy Warren, Messrs. A. W. Borthwick, J. Steele Elliot, W. A. Gain, A. Hartley, H. H. Macnabb, W. Moss, Jas. N. Milne,

R. A. Phillips, H. B. Rathbourne, R. F. Scharff, E. W. Swanton, J. Taunton, A. T. Wilson, B. B. Woodward, G. W. Wood, and Morris Young.

2. *The Constancy of Anatomical Characters.*

During the last ten years nearly all the new species of Slugs have been constituted upon differences in the form and position of the generative organs, as may be readily seen by a reference to the writings of Simroth, Lessona, Pollonera, Godwin-Austen, and others. The external characters of such a group are exceedingly unreliable, for the colour, markings, &c. are liable to a wide range of variation in each individual species. Mr. Cockerell (3) has very decidedly questioned—strange as it may seem—the validity of anatomical characters for generic or specific distinction. Writing in 1892 (3. p. 4) he says:—"Here there is undoubtedly danger of error, since it is difficult to find out in many cases what is the stability of the apparent anatomical distinction. . . . Nothing should be more strongly insisted upon than the impossibility of applying the same tests of specific validity throughout series of genera; for characters that are generic in one place may not be specific in another." Mr. Cockerell is, I fear, dogmatizing upon a subject which he has not taken the trouble to actually work out; for, so far as I am aware, there is not a single valid genus of European Slugs in which good anatomical features cannot be set forth as characteristic of this or that particular genus. As I have elsewhere stated (8), for the separation of genera the aggregate characters should be the basis for distinction; but for specific distinction the form and position of the generative organs is undoubtedly a reliable basis, provided that undue importance is not attached to minute variations due to age, season of the year, &c.

More recently Messrs. Cockerell & Larkin (4) have attempted to substantiate the statement concerning the stability, or, as I prefer to term it, the constancy, of the form of certain parts of the generative organs in *Veronicella*. A careful perusal of this paper only proves, to my mind, that the results obtained are of little or no value as regards the subject under discussion, for the authors are not certain whether they are dealing with variations in two, three, or four species[1]. Some of the specimens, I am of opinion, were not full-grown, while in others the variations noted are of the most trifling character. Where such investigations are undertaken, it is surely necessary, if the results are to be of any value, to be quite certain of the species; further, the number of specimens examined, and the proportion of variations found in each collection, if from more than one locality, should be stated.

With a view to proving how little important variation occurs in the form of the terminal ducts of the generative organs, I have during the past four or five years carried out a series of investi-

[1] In a footnote the authors state that Dr. Simroth considered some specimens submitted to him as distinct species.

gations upon two common and widely distributed species, viz., *Arion subfuscus*, Drap., and *A. hortensis*, Fér., which are detailed below.

ARION SUBFUSCUS, Drap.

The form and position of the generative organs in this species are illustrated on Pl. XXIX. fig. 1. Externally the species is one subject to a wide range of variation. I have myself noted some thirty minor colour-variations in addition to the fifty or sixty varieties which have been described by various authors. If this species assumes different colours, markings, &c. in different districts, which it undoubtedly does, in common with nearly all other species, the value of such as distinctive features is materially lessened, and one is led to ask "Does the form of the generative organs vary to a similar extent?"

I have examined 152 lots of this species, each from different localities in various parts of Europe, including in all 751 specimens. All of these were adult and collected during the months of July and August in 1892–3–4–5. Out of this large collection in only four of the lots were variations found, particulars of which are as follows:—

1. Four specimens collected at Southampton (Pl. XXIX. fig. 2). In three specimens the sperm-duct had a globose ring-like swelling at its commencement, and the free-oviduct showed the globose form figured. Professor Simroth, who examined a specimen, considered it "a very developed *A. subfuscus*."

2. Three specimens from Ireland (Pl. XXIX. fig. 3). All slightly smaller and darker than the typical form. All three specimens exhibited a slight difference in the form of the free-oviduct.

3. Five specimens collected near Knowle, Warwick (Pl. XXIX. fig. 4). All belonging to the variety *griseus*, Cllge. In one specimen the form of the free-oviduct was somewhat like that in No. 1 (fig. 2), only less globose and more constricted in the middle of the lower portion.

4. Five specimens collected in Northern Italy (precise locality uncertain). In two specimens both the sperm-duct and free-oviduct differed slightly (Pl. XXIX. fig. 5).

In all the above variations it will be seen, on comparing figures 2 to 5 with figure 1, that the distinction between the upper and lower portion of the free-oviduct was very sharply marked.

ARION HORTENSIS, Fér.

Only 83 lots of this species have been examined, each from a different locality, including in all 491 specimens. In 19 specimens the generative organs were found to be immature, thus leaving 472. Variations were found in six cases.

1. Two specimens from Tuxford, Newark (Pl. XXX. fig. 7). In one the free-oviduct was longer than usual and the sperm-duct more globose.

2. Ten specimens from Ireland (Pl. XXX. fig. 8). Three speci-

mens showed a peculiar series of constrictions in the sperm-duct, and slight constrictions in the free-oviduct.

3. Seven specimens from Northern Italy (precise locality uncertain). The difference from the typical form was very slight, the most marked character being the gradual tapering of the free-oviduct (Pl. XXX. fig. 9).

4. Nine specimens from St. Andrews, N.B. (Pl. XXX. fig. 10). In one example the sperm-duct had the peculiar form figured, and was sharply marked off from the vas deferens.

5. Twenty-seven specimens from Ireland (Pl. XXX. fig. 11). In two examples in this collection the vas deferens was sharply marked off from the sperm-duct, which approached in form that mentioned in the previous collection *(cf.* fig. 10).

6. Thirteen specimens collected at Bern, Switzerland (Pl. XXX. fig. 12). Three specimens showed the globose form of the lower portion of the sperm-duct, and differed somewhat from the type in the form of the free-oviduct.

It will thus be seen that out of 1223 specimens of *A. subfuscus*, Drap., and *A. hortensis*, Fér., from 235 localities, in only 26 specimens were variations discovered from 10 localities, and three of these were presumably not constant, being found only in individual specimens.

I am of opinion, therefore, from these and other investigations (9) that the form and position of the generative organs in these two species are of the greatest value, and exceedingly reliable for purposes of specific distinction. Further, wherever the form and position of these organs differed, and these differences were constant in a given number of specimens, I should unhesitatingly describe them as distinct species, irrespective of external colouring or markings.

Of course, to anyone acquainted only with the form of the generative organs in a very few species, or a small number of any given species, slight differences are apt to receive a wrong interpretation, and an undue importance is very often attached to such; but the experienced malacologist knows that slight differences due to age, season of the year, &c. are constantly found, and are just as worthless as permanent and well-marked differences are valuable. Until, therefore, the variations in any particular species or group of species are shown to be very great, I do not think we can do better than retain the form and position of the generative organs as our basis for specific distinction.

3. *A Reversion of a Colour Variation.*

A few years ago Mr. Gain described some very interesting observations upon the colour changes *Arion intermedius*, Normand, undergoes (12), and later I have noted similar colour variations in other species.

The present case is, I think, still more interesting than either of the above.

In the autumn of 1896 I received a specimen of the white

variety of *A. empiricorum*, Fér., from Roundhay near Leeds. It was of an almost pure white, not the creamy-yellow variety which is much commoner. For some months the specimen was kept alive beneath a bell-jar on a large flower-pot, and liberally supplied with leaves of lettuce, cabbage, &c. During this period I witnessed a complete reversion to the typical black form. After I had kept the animal for about five weeks, I noticed that it looked much dirtier than previously, and about the seventh week it was a very dirty white, which quickly changed into a faint sepia. About the ninth week it became very inactive, and for three weeks, whenever I examined it, it was drawn up in the peculiar arched form so characteristic of this and a few other species of *Arion*. During this time a large amount of thick dark yellow slime was exuded from the caudal mucous pore, and remained over the postero-dorsal region of the body. Little by little the colour deepened, and the animal became more active about the middle of the fourth month, by which time it was almost black: by the end of the fifth month it was impossible to distinguish it from the typical black forms.

I have previously seen examples of this Slug undergo slight changes in colour, such as the black forms becoming much lighter, a dark sepia; but I know of no instance of so complete a change as the one here described, viz., a complete reversion to the normal colour from a pure white.

4. *The Specific Validity of* Arion fuscus, *Müll.*

Through the kindness of Signor Pollonera, I was able in 1892 to examine specimens of this species, and from the slight differences I was able to detect in the form of the generative organs in these specimens, I was inclined to regard it as a variety of *A. subfuscus*, Drap. (7). Since then I have been able to make a more careful examination on some better material, for which I am indebted to the kindness of Herr Joseph F. Babor, of Prague University; and I am of now of opinion that, from the differences in the form of the generative organs, it must be regarded as a distinct species.

Arion fuscus, Müller, 1774.

Limax fuscus, Müller, Verm. Hist., 1774, vol. ii. p. 11.

Arion fuscus, Mörch, Vidensk. Medd. naturhist. For. Kjöbenhavn, 1863, p. 273.

Prolepis fuscus, Malm, Skand. Land-Sniglar, 1870, p. 43, pl. ii. fig. 4.

Arion rufus (partim), Westerl., Exposé critique Moll. Suède et Norv., 1871, p. 32.

Arion citrinus, Westerl., Exposé critique Moll. Suède et Norv., 1871, p. 35.

Arion stabilei, Poll., Atti Acc. Sci. Torino, 1885, p. 28.

Arion fuscus, Poll., Atti Acc. Sci. Torino, 1887.

This species is much smaller than *A. subfuscus*, with the bands on the mantle distinct; the lines on the foot-fringe vary from dark

brown to pale yellow, when of the latter colour they are usually more intense in the region of the caudal pore. Long. max. 40–55 millim.

There is a single vestibule, from which the sperm-duct opens in the form of an expanded tube; it is comparatively larger than in *A. subfuscus*, and is folded upon itself at the point where the vas deferens commences, which organ is also considerably longer than in *A. subfuscus* (Pls. XXX. & XXXI. figs. 13–14). The free-oviduct is a long, wide, and somewhat S-shaped tube. In none of the specimens I have examined does it approach the form so characteristic of *A. subfuscus* (Pl. XXIX. fig. 1, *f.ov.*). The retractor muscle is attached about the middle, whereas in *subfuscus* it is attached to the upper third. The receptacular duct is long and thin, expanding at its head into the spherical receptaculum seminis. The retractor muscle is attached to the duct just below the head. The common duct is thrown into a series of convolutions terminally, and shorter than in *subfuscus*. The hermaphrodite gland is a small, dark-coloured, ovoid or pyriform body with a long convoluted duct.

Babor's description of the reproductive organs of *A. citrinus*, Wester. (2), leaves no doubt as to it being Müller's *A. fuscus*. I have reproduced his careful figures of these organs (Pl. XXXI. figs. 15–16), and also those of the variety *boettgeri*, Poll. (Pl. XXXI. fig. 17), which according to this author is characterized anatomically by the short receptacular duct, a feature which I can confirm.

5. *Description of a new Species of* Arion.

In 1892 (5) I recorded a new variety of the well-known *Arion hortensis*, Fér., under the name of *cæruleus*. The specimens had been very kindly sent to me from Ireland by Dr. R. F. Scharff. I pointed out in the description of this variety that possibly, when further investigated, its anatomical characters might prove to be more permanent than I then supposed. Since that date specimens have been sent to me by Mr. B. B. Woodward from Ealing (10), by Mr. H. Horsman Macnabb from Heaton, Lancashire, and I have myself collected examples near Oxford and elsewhere. After having made a careful examination of this material, I feel convinced that this form is sufficiently distinct both externally and internally to be separated from *A. hortensis*, Fér., as a distinct species.

Arion cæruleus, sp. nov.

Arion hortensis, Fér., var. *cæruleus*, Collinge, Conchologist, 1892, vol. ii. p. 26.

Body blue or greyish blue, with conspicuous dark blue lateral bands, and pale yellow ground-colour between these and the foot-fringe; mantle with dark bluish central patch, and darker bands at each side; head and tentacles bluish grey; foot-fringe white, usually without lineoles; foot-sole white or very pale yellow; rugæ flat, large, and elongated; sulci dark.

Length (in alcohol) 27–33 millim.; alive 43 millim.

Hab. Co. Dublin, Ireland; Berkshire, Lancashire, Oxford, and Middlesex, England.

Anatomy of the Generative Organs.—The organs are generally larger than those in *A. hortensis*, Fér. There are two vestibules, the lower one being considerably larger than the upper. The lower portion of the sperm-duct forms a globose swelling, above this a wide tube gradually tapering as it approaches the vas deferens, which is sharply marked off from the sperm-duct. The vas deferens is rather longer than in *A. hortensis*. The free-oviduct is very distinct from that in any form of *A. hortensis* which I have seen, and quite unlike any species of the *A. hortensis* group, in having the lower portion of the free-oviduct much larger and more globose than the upper, which is a narrow tube (Pl. XXXI. fig. 19). The retractor muscle is attached to the upper part of the lower division of the free-oviduct. The receptacular duct is short, expanding terminally into the spherical sac, the receptaculum seminis. The remaining parts of the generative organs are similar to those of *A. hortensis*, Fér.

A comparison of figures 18 and 19 with those numbered 6 to 12 will illustrate the more striking differences.

In fig. 6 we have the terminal ducts of the generative organs of a typical *A. hortensis*, and a variation (fig. 12) which is the nearest to *A. cæruleus*.

Alcoholic specimens of *A. hortensis*, Fér., and *A. cæruleus* are very readily distinguished from one another, even more so than when alive, although the external features of *A. cæruleus* are much more distinctly marked than in any other member of this group.

6. *Synopsis and Classification of the Genus.*

The genus *Arion* as now understood by malacologists was constituted by Férussac (**11**) in 1819. Brard (1815) divided Linné's genus *Limax* into two genera, retaining Linné's name for those species without a shell, and constituted the new genus *Limacella* for those species possessing a shell.

Jousseaume (**13**) is the only malacologist I know of who has adopted this classification. Hartman (1821) used the name of *Limacia* for the genus.

Moquin-Tandon in 1855 (**17**) divided the genus into the two following subgenera:—

Lochea, where the shell-plate was absent and represented only by small, unequal, isolated granulations.

Prolepis, where the shell-plate was present in the form of an aggregation of separate calcareous particles.

In 1868 Mabille (**15**) constituted the genus *Baudonia* for two species of Portuguese slugs, *B. timida* and *B. montana*, which were distinguished from *Arion* by being anteriorly enlarged and depressed, with an almost smooth mantle, the head well separated from the body, and the tentacles small. It is hardly necessary to say that such superficial differences are of very little value, and

certainly not sufficient to constitute either a new genus or subgenus.

In 1870 Mabille (16) gave the *Arion fasciatus* group, mentioned on p. 447 in this article, the name of *Carinella*, under the impression that all the species were keeled, which, however, is not the case, as I have elsewhere pointed out (6). Seibert in 1873 (Nachr. malak. Gesell. vol. v. p. 81) proposed the name *Kolbeltia* for the *A. hortensis* group. Later Simroth (22), 1885, divided the genus into two sections, the *Monatriidæ* and *Diatriidæ*. In the former division all species possessing a single vestibule were grouped, and in the latter all those in which the oviduct before opening into the lower vestibule dilates, thus forming as it were a second vestibule. Pollonera (19), 1887, has very clearly shown that such a character as the presence of either one or two vestibules cannot serve as a basis for classification, it not being a feature of sufficient importance. Further, he thinks that Simroth attached too much importance to such a character, through his having limited his study to the few Germanic forms. Pollonera showed that we not only find in the same groups species which are *Monatriidæ* and species which are *Diatriidæ*, but also that in the four groups into which he has divided *A. hortensis* two species are *Diatriidæ* (*A. hortensis* and *A. celticus*) and two are *Monatriidæ* (*A. alpinus* and *A. nilssoni*); further the *A. bavayi* belongs to the so-called *Monatriidæ*, while *A. rufus* and *A. ater* are the two species in which the *Diatriidæ* condition is most marked. In a later paper (21) this distinguished malacologist points out that the *A. hortensis* from the North of France are all *Monatriidæ*, whereas those from Germany are *Diatriidæ*, while those from the East of France are *intermediate between the two*. From these facts I think it will be evident that we can no longer separate the members of the genus *Arion* by the number of vestibules they possess into subgenera, groups, &c. The character is interesting and may possibly be of service in separating species, but as a feature for generic distinctions is useless.

Pollonera has suggested (19) the division of the genus into four groups, viz.:—

1. The *Arion empiricorum* group.
2. The *Arion subfuscus* group.
3. The *Arion hortensis* group.
4. The *Arion bourguignati* group.

I think this suggestion preferable to any yet proposed, and it is the one I have here followed, with some slight alterations, as shown in the following synopsis of the genus.

Synopsis of the Genus *Arion*.

1. The *Arion ater* group [1].

The animal is large and unicolour in the adult. Rarely banded

[1] I use the name *ater* for this group, as it is an older species than *A. empiricorum*.

or striped, excepting in young specimens. Mantle large. Adult never keeled. Free-oviduct of moderate length, with its terminal portion usually globose or expanded. Sperm-duct usually, but not always, opens into the vestibule by a thickened ring-like swelling. Retractor muscle of the free-oviduct always situated above the lower portion, and joins with that supplying the receptaculum seminis.

2. The *Arion subfuscus* group.

Usually banded, variable in colour. Varies in size from 35 to 75 millim. Mantle rather large. Adult never keeled. Free-oviduct generally sac-like or wide and long, without well-defined terminal swelling. Duct of receptaculum seminis usually long. Retractor muscles of the free-oviduct and receptaculum seminis usually distinct or only slenderly united.

3. The *Arion hortensis* group.

Nearly always banded, of dark colour. Varies in size from 30 to 55 millim. Mantle medium-sized, often small. Adult never keeled. Sperm-duct usually long and tapering, passing imperceptibly into the vas deferens. Free-oviduct gradually tapering. Retractor muscles usually united, but only slenderly.

4. The *Arion fasciatus* group.

Nearly always banded. In external appearance agrees very closely with the preceding group. Body sometimes keeled. Head of receptaculum seminis elongated, duct short.

5. The *Arion intermedius* group.

Animal usually of small size, varying from 15 to 27 millim. Mantle almost circular. Adult never keeled. Receptacular duct short and broad.

Lessona and Pollonera (14) are wrong in stating, as one of the characters of the genus, that the penis (=sperm-duct) and vas deferens are quite distinct, and do not pass imperceptibly into one another as in *Ariunculus*, for in numerous species there is no marked difference between the two.

The term penis cannot be used for the male organ in this genus; as has been pointed out by Simroth, it is not evertible, and has no retractor muscle, its function being for the storage of the spermatozoa. The free-oviduct assumes the function of the penis in this genus. It is evertible and provided with a retractor muscle. Messrs. Pilsbry and Vanatta (18) have suggested the term *epiphallus* for what I term sperm-duct, and *vagina* for what I term free-oviduct. I think it preferable, however, to retain the term epiphallus for the terminal portion of the vas deferens above the sperm-duct; the term vagina is not applicable to the genus *Arion*.

CLASSIFICATION.

Family ARIONIDÆ, Gray, 1840.

Subfam. ARIONINÆ, W. G. Binney, 1864.

Genus ARION, Férussac, 1819.

GROUP I.

1. A. ater, Linné, 1758. (Continent.)
2. A. rufus, Linné, 1758. (Continent.)
3. A. empiricorum, Férussac, 1819. (British Isles and Continent.)
4. A. lusitanicus, Mabille, 1868. (British Isles and Continent.)
5. A. brevièrei, Pollonera, 1887. (Continent.)
6. A. dasilvæ, Pollonera, 1887. (Continent.)
7. *A. aggericola*, Mabille, 1870 [1]. (Continent.)
8. A. flagellus, Collinge, 1893. (Ireland and Continent.)

GROUP II.

9. A. subfuscus, Draparnaud, 1805. (British Isles and Continent.)
10. A. fuscus, Müller, 1774. (Continent.)
11. A. bavayi, Pollonera, 1887. (Continent.)
12. A. pegorarii, Lessona & Pollonera, 1882. (Continent.)
13. A. flavus, Nilsson, 1822. (Continent.)

GROUP III.

14. A. hortensis, Férussae, 1819. (British Isles and Continent.)
15. A. anthracius, Bourguignat, 1866. (Continent.)
16. A. cæruleus, Collinge, 1897. (British Isles.)
17. A. cottianus, Pollonera, 1887. (British Isles ? a Continent.)
18. A. nilssoni, Pollonera, 1887. (Continent.)
19. A. alpinus, Pollonera, 1887. (Continent.)
20. A. hessei, Simroth, 1894. (Continent.)
21. A. elongatus, Collinge, 1894. (British Isles.)

GROUP IV.

22. A. fasciatus, Nilsson, 1822. (British Isles and Continent.)
23. A. subcarinatus, Pollonera, 1885. (Continent.)

[1] At present this must be regarded as a doubtful species. Mabille placed it in the *A. subfuscus* group (**16**), but Pollonera (**21**) states that from the radula it belongs to the *A. ater* group, being a form allied to *A. brevièrei*, Poll., from which it differs by its smaller size, brighter colour, small receptaculum seminis, shorter receptacular duct, and by the great length of the sperm-duct.

Group V.

24. **A. intermedius**, Normand, 1852. (British Isles and Continent.)
25. **A. molleri**, Pollonera, 1889. (Continent.)
26. **A. pascalianus**, Mabille, 1868. (Continent.)
27. **A. vejdovskijii**, Babor & Kostal, 1893. (Continent.)

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EXPLANATION OF PLATES XXIX.–XXXI.

Fig. 1. The terminal ducts of the generative organs of *Arion subfuscus*, Drap.
Fig. 2. The same, showing variation in the form of the free-oviduct.
Figs. 3, 4, & 5. The same, showing variations in the form of the terminal ducts.
Fig. 6. The terminal ducts of the generative organs of *Arion hortensis*, Fér.
Figs. 7, 8, 9, 10, 11, & 12. The same, showing variations in the form of the terminal ducts.
Fig. 13. The generative organs of *Arion fuscus*, Müll.
Fig. 14. The terminal ducts of the same in natural position.
Fig. 15. The terminal ducts of the generative organs of *Arion citrinus* Westerl. (After Babor.)
Fig. 16. The generative organs of *A. citrinus*. (After Babor.)
Fig. 17. The terminal ducts of the generative organs of *Arion fuscus*, var. *boettgeri*, Poll. (After Babor.)
Figs. 18, 19. The terminal ducts of the generative organs of *Arion cæruleus*, Cllge.

Lettering.

alb.gl. Albumen-gland.
f.ov. Free-oviduct.
h.d. Hermaphrodite duct.
h.gl. Hermaphrodite gland.
l.v. Lower vestibule.
ov. Oviduct.
pr. Prostate.
rd. Receptacular duct.
r.m. Retractor muscles.
r.s. Receptaculum seminis.
s.d. Sperm-duct.
u.v. Upper vestibule.
v.d. Vas deferens.

3. Field-Notes on the Antelopes of the Mau District, British East Africa. By Frederick J. Jackson, F.Z.S. With Remarks by P. L. Sclater.

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[Mr. Jackson, who is now in command of 'Ravine Station' at the edge of the Mau Plateau on the main route from Mombasa to Lake Victoria, has, in reply to some enquiries, kindly favoured me with the subjoined field-notes on the Antelopes of the district in which he is resident.—P. L. S.]

1. Bubalis cokei (Günth.).

I am doing my best to ascertain the ranges of the various Antelopes, but find it somewhat difficult. I thought I had quite